



# First record of the White-winged Vampire bat, *Diaemus youngii* (Jentink, 1893) (Chiroptera, Phyllostomidae) for the state of Goiás, Brazil, with a revised distribution map

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## Abstract

*Diaemus youngii* (Jentink, 1893) is a widespread species occurring from southern Mexico to northern Argentina. Along its distribution, however, this bat is rare to uncommon. Here, we report its record for the state of Goiás, central-western Brazil, based on a specimen found in the mammal collection of the Instituto Nacional da Mata Atlântica, former Museu de Biologia Professor Mello Leitão. *Diaemus youngii* is known from 129 unique localities, with 81 (over 62%) in Brazil, followed by Peru (7), Bolivia (6) and Venezuela (6). It is absent in the west of the Andes, southern Argentina, Uruguay, and Caribbean islands, except for Trinidad.

## Key words

Cerrado, Desmodontinae, Neotropical region, scientific collection.

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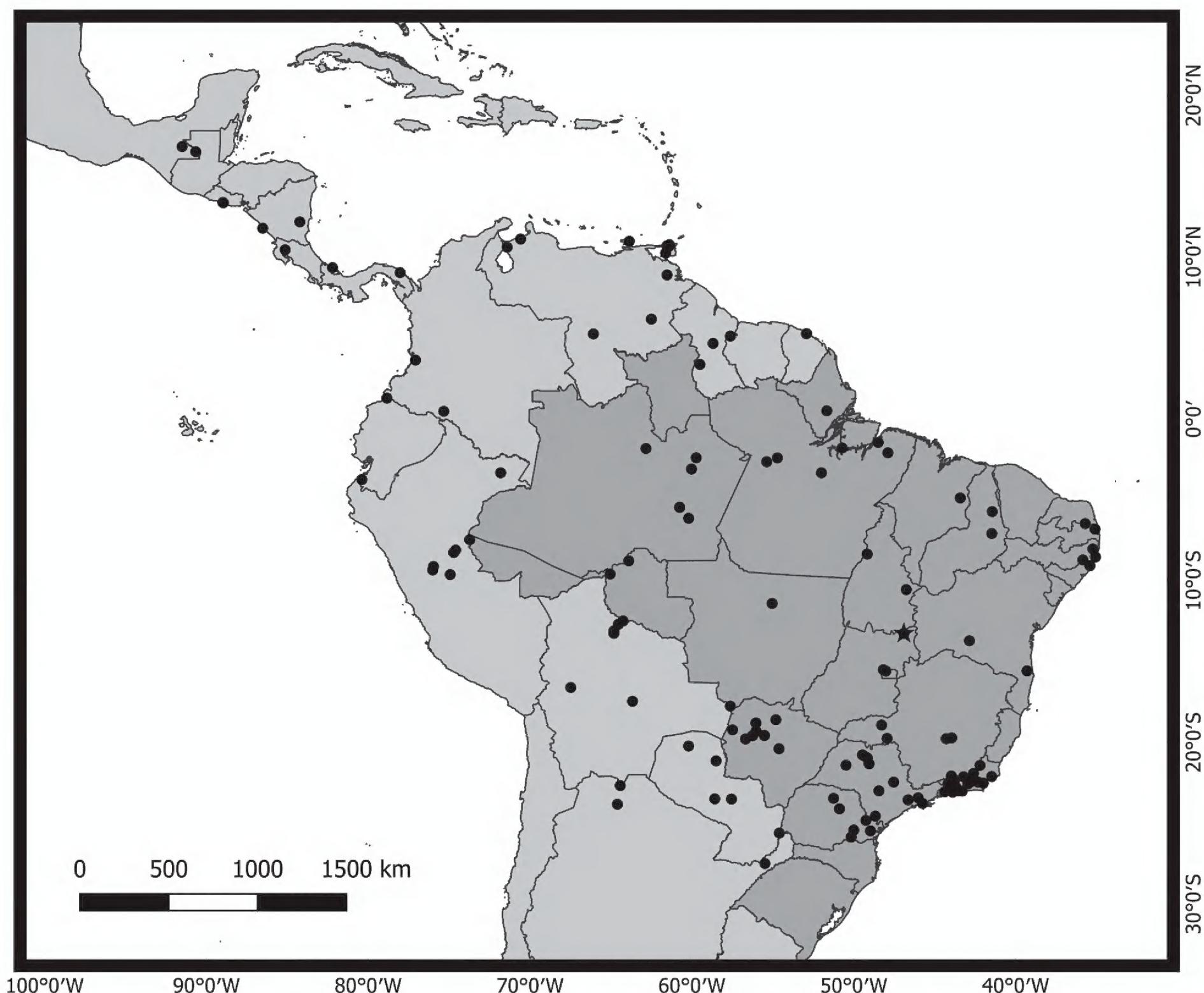
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## Introduction

Bats are still widely held as evil, disease-carrying, blood-sucking animals, especially in the western world, where old myths persist (Teixeira and Papavero 2003). However, only 3 among the more than 1,300 extant bat species feed on blood: *Desmodus rotundus* (É. Geoffroy Saint-Hilaire, 1810), *Diphylla ecaudata* Spix, 1823, and *Diaemus youngii* (Jentink, 1893). These 3 species belong to the Desmodontinae subfamily and are endemic of the Americas. These bats also share several adaptations that allow the consumption and digestion of blood: sharp, canine-like incisors, saliva with anticoagulant

components, and a sac-like elastic stomach, specialized for liquid absorption (Kwon and Gardner 2008). Due to their feeding habits, vampire bats are of epidemiological concern, especially for their role in the transmission of rabies in rural areas, affecting humans and other mammals (Calisher et al. 2006, Dantas-Torres 2008).

*Diaemus youngii* has a wide distribution, occurring from Mexico to northern Argentina (Kwon and Gardner 2008). Along its distribution, however, it is a rare to uncommon species (Aguiar et al. 2006). In Brazil, few records are available for most states where this bat has been found, and some well-studied states still lack records (e.g., Espírito Santo, Mendes et al. 2010). While



**Figure 1.** Known localities of *Diaemus youngii*. The star points the new occurrence at Monte Alegre de Goiás, state of Goiás, Brazil. See supplementary material for coordinates and literature sources.

examining material in a museum mammal collection, we discovered a specimen of *D. youngii* that fills the gap for the state of Goiás. Here we report this finding and provide an updated map covering the whole distribution of the species.

## Methods

The specimen of *D. youngii* is housed in the mammal collection of the Instituto Nacional da Mata Atlântica, Santa Teresa (INMA), Brazil, formerly known as Museu de Biologia Professor Mello Leitão. Craniodental measurements were obtained using a digital caliper calibrated to the nearest 0.01 mm, following the protocol devised by Vizotto and Taddei (1973). We gathered all available published records of *D. youngii* from the literature, giving preference to the primary sources (see Appendix).

## Results

**New records and distribution map.** *Diaemus youngii*, MBML 2005, previously ISDF 1047, adult female,

orchard next to a poultry farm, Monte Alegre de Goiás, Goiás, Brazil (13°15'23" S, 046°54'02" W). The species is known from 129 unique localities from 16 countries, with Brazil (81 localities), Peru (7), Bolivia (6) and Venezuela (6) being the most represented (Fig. 1). Craniodental measurements (Table 1). A. Bredt, E. Magalhães, P.H. Oliveira, 25 April 1995.

**Identification.** We used the identification keys of Kwon and Gardner (2008) and Díaz et al. (2016) to identify our specimen. *Diaemus youngii* can be differentiated from *De. rotundus* and *Di. ecaudata*, by presenting moderately elongated thumbs with 1 basal pad, white wing-tips, and 2 upper molars on each side (Greenhall and Schutt 1996). Our specimen was confidently identified based on these characteristics (Fig. 2), and overall agrees with descriptions in the literature. The inner lower incisors are described as trilobated (Kwon and Gardner 2008), but in our specimen these teeth are worn down (Fig. 2A). Notwithstanding, Greenhall and Schutt (1996) have noticed that the lower incisors in *Diaemus* tend to vary in kind and degree of lobation. Mensural data from our specimen are close to those reported for the holotype (Carter and Dolan 1978), and for specimens from

central-western and northern Brazil (Pedroso et al. 2018), and Venezuela and Trinidad (Greenhall and Schutt 1996) (Table 1). These data suggest little size variation within *D. youngii*, but larger samples are required to further investigate this aspect.

## Discussion

Desmodontinae are known to feed on mammalian and avian blood, with *Di. ecaudata* regarded as an avian blood specialist, while *De. rotundus* and *D. youngii* feed on a broader spectrum (Ito et al. 2016). However, *D. youngii* seems to prefer avian blood, perhaps to avoid competition of resources with *De. rotundus* (Gardner 1977, Sazima and Uieda 1980, Greenhall and Schutt 1996). Our specimen was collected in an orchard, but next to a poultry farm containing a few dozen chickens. Unfortunately, the records did not mention if the fowl presented bite marks or signs of decaying health.

Vampire bats are habitually exposed to blood, even by sharing blood meals with conspecifics in their roost places (Wilkinson 1984), increasing the odds of acquiring rabies virus (RABV). RABV are frequently isolated from *De. rotundus*, but less commonly in other hematophagous bats (Castilho et al. 2010). There are a few positive RABV isolates from *D. youngii*, with reports from the Brazilian states of Piauí and Maranhão (Castilho et al. 2010, Póvoas et al. 2012), and also Mexico and Trinidad and Tobago (Escobar et al. 2015). Before donation to INMA, the specimen reported here was screened for RABV by the Instituto de Saúde do Distrito Federal (ISDF, number 1047), with negative results. *Desmodus rotundus* can efficiently digest mammal blood and was thought to be the only vampire bat preying on humans. However, there are at least 2 records of *Di. ecaudata*, an avian blood specialist with physiological adaptations similar to *D. youngii* (see Ito et al. 2016), feeding on humans (Ruschi 1953, Ito et al. 2016).

Housing conditions may influence the foraging behavior of vampire bats, especially in rural or poor areas where domestic animals, often maintained together, are in close proximity with human facilities. *Diaemus youngii* has also been captured in urban areas (Urbíeta et al. 2017). These conditions favor the transmission of RABV, even if indirectly (Turner 1975).

According to the literature, *D. youngii* has a wide distribution in the Neotropical region, occurring from southern Mexico to northern Argentina. It seems to be absent, however, from the west of the Andes and most Caribbean islands (except for Trinidad). Suriname, Chile, and Uruguay, in South America, and Belize and Honduras, in Central America also lack records (Fig. 1; see also Greenhall and Schutt 1996). The distribution of this species seems to be influenced by thermoregulation issues (e.g. intolerance to colder climates), shared with *Diphylla*, but not with *Desmodus* (McNab 1969). The latter genus of bat has a greater ability to maintain its body temperature, and its distribution is known to reach as far as Chile and Uruguay (Acosta y Lara 1950, Delpietro et al. 2017). The absence of *D. youngii* in Honduras (Goodwin 1942, Valdez and LaVal 1971), Belize (Fenton et al. 2001), and Suriname, however, may represent sampling gaps. In northern South America, all countries bordering Suriname have reported its occurrence (Piccinini 1974, Peracchi et al. 1984, Bernard and Fenton 2002).

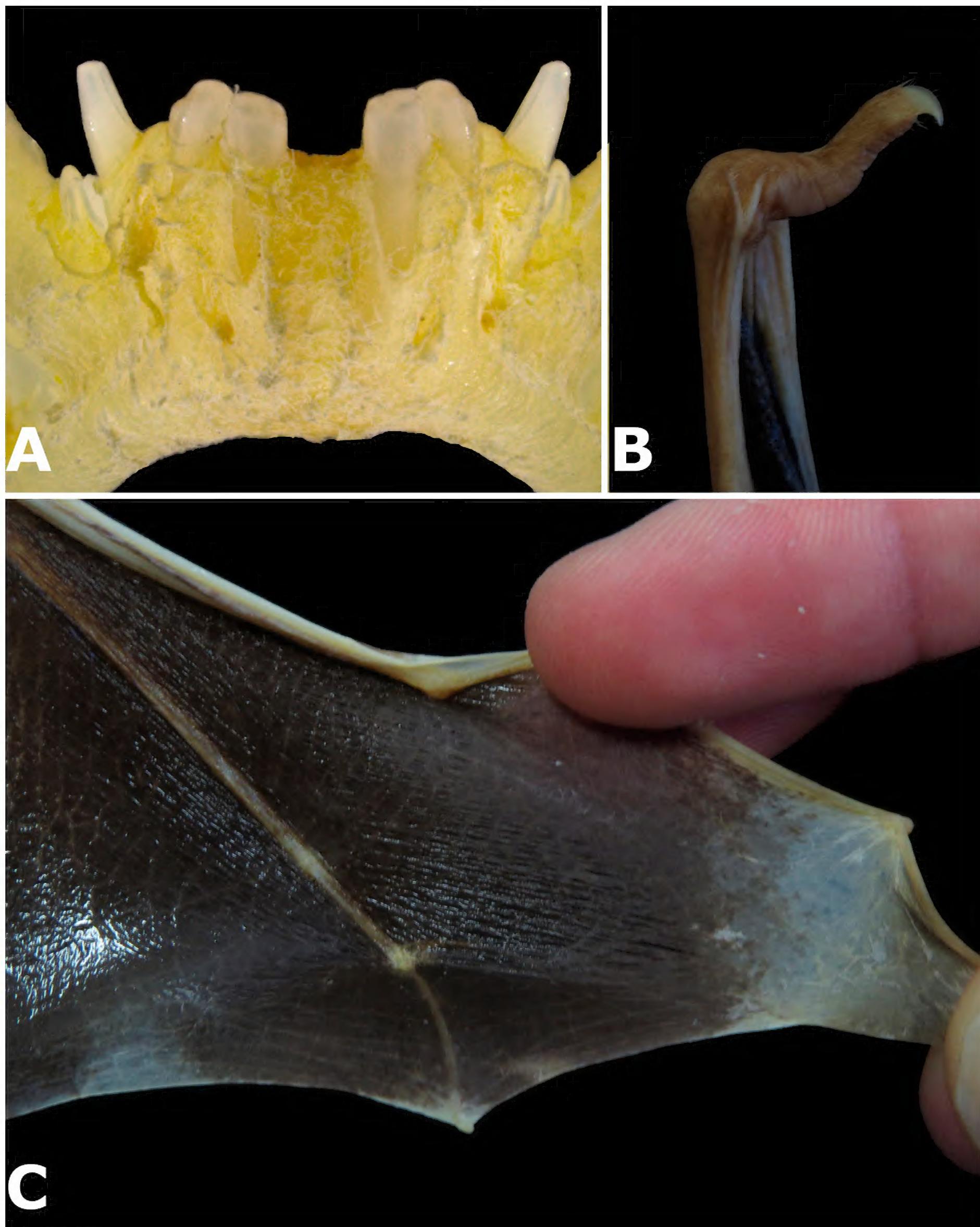
The large number of records of *D. youngii* in southeastern Brazil, especially in Rio de Janeiro and São Paulo, can be attributed to the long-duration surveys conducted in those states (Esbérard and Bergallo 2005, Garbino 2016). Contrasting with the situation in this region, however, the majority of the Brazilian territory is poorly sampled (Bernard et al. 2011), including the northeastern region. Some efforts have been made recently in this region, but no record of *D. youngii* is currently available from Rio Grande do Norte (Vargas-Mena et al. 2018), Ceará (Silva et al. 2015) and Roraima (Capaverde Junior

**Table 1.** Craniodental measurements (in mm) of *Diaemus youngii* from Monte Alegre de Goiás, Goiás, Brazil (MBML 2005), and comparative data for the holotype (Upper Canje Creek, Guyana; RNH 12088; Carter and Dolan 1978), and for material from central-western and northern Brazil (Pedroso et al. 2018), and from Trinidad and Venezuela (Greenhall and Schutt 1996).

Variables	MBML 2005 (GO)	Holotype	Greenhall and Schutt 1996 <sup>†</sup>	Pedroso et al. 2018 <sup>‡</sup>
Greatest length of skull	24.35	25.0	24.8	25.61
Condylar length	21.58	23.0	—	21.01
Condylar-canine length	19.63	—	—	—
Basal length	19.63	—	—	—
Palatal length	8.72	—	—	7.84
Upper toothrow length	3.10	3.5	3.5	5.61
Width across upper molars	6.28	—	—	6.58
Postorbital length	6.34	6.5	6.2	6.32
Braincase breadth	13.17	13.5	13.0	13.02
Zygomatic breadth	13.91	14.3	13.9	13.99
Mandibular length	14.70	15.2	—	15.15
Lower toothrow length	4.17	4.2	—	—

<sup>†</sup>Mean values for 3 males.

<sup>‡</sup>Mean values for 5 females.



**Figure 2.** *Diaemus youngii* from Goiás state, Brazil (MBML 2005). **A.** Lower incisors. **B.** Right thumb, showing the single basal pad. **C.** Right wing, depicting the white wingtip characteristic of this species.

et al. 2014). Absences from the southern states of Rio Grande do Sul and Santa Catarina, on the other hand, may be related to their colder climates, as previously reported for Uruguay (Acosta y Lara 1950).

The new record of *D. youngii* reported here covers a gap in the middle of the Cerrado, with the closest localities known to harbor this species being, respectively,

Brazlândia, Distrito Federal (280 km north; Aguiar et al. 2006) and Estação Ecológica Serra Geral do Tocantins, Jalapão (300 km south; Gregorin et al. 2011).

The first director of the Museum of Vertebrate Zoology (University of California), Joseph Grinnell, wrote in 1910 on the importance of museum collections (Grinnell 1910):

It will be observed, then, that our efforts are not merely to accumulate as great a mass of animal remains as possible. On the contrary, we are expending even more time than would be required for the collection of the specimens alone, in rendering what we do obtain as permanently valuable as we know how, to the ecologist as well as to the systematist. It is quite probable that the facts of distribution, life history, and economic status may finally prove to be of more far-reaching value, than whatever information is obtainable exclusively from the specimens themselves.

Unfortunately, without proper care and maintenance, these fundamental repositories of biodiversity can be tragically lost, as recently seen in the Museu Nacional do Rio de Janeiro and in the Instituto Butantan, both in Brazil. It is widely recognized that most species in the world have yet to be described (Mora et al. 2011), and a significant part is already waiting for description in a museum collection (Fontaine et al. 2012). Our report, based on a specimen collected more than 20 years ago, reinforces the role of collections, in helping with the basic knowledge of “where” a species can be found.

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## Authors' Contributions

JPMH examined and identified the specimen, prepared the map and figures. GM took cranial measurements. All authors wrote, revised, and approved the manuscript.

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## Appendix

**Table A1.** Gazetteer of all reported occurrences of *Diaemus youngii* (Jentink, 1893).

Country	State/province	Locality	Latitude	Longitude	Reference	Page	Coll. number
Argentina	Jujuy	Agua Salada	23°49'00" S	064°36'00" W	Barquez 1984	67	FML 1343
	Misiones	Bonpland	27°29'00" S	055°29'00" W	Kwon and Gardner 2008	222	—
	Salta	Arroyo Arrazayal	22°39'51" S	064°25'31" W	Barquez et al. 2011	17	CML 7700
Bolivia	Beni	15 km above Horquilla, Rio Machupo	12°41'00" S	064°32'00" W	Anderson et al. 1982	15	—
	Beni	4 km S San Joaquín, San Juan	13°06'00" S	064°49'00" W	Anderson et al. 1982	15	—
	Beni	Estancia Yutiole	13°15'00" S	064°49'00" W	Anderson et al. 1982	16	—
	Beni	Rio Itenez, 4 km above Costa Marquez	12°29'00" S	064°15'00" W	Anderson et al. 1982	14	—
	La Paz	Pasto Grande	16°36'00" S	067°29'00" W	Kwon and Gardner 2008	222	—
	Santa Cruz	Buena Vista	17°27'00" S	063°40'00" W	Kwon and Gardner 2008	222	—
Brazil	Acre	Parque Nacional da Serra do Divisor	07°27'30" S	073°43'55" W	Nogueira et al. 1999	366	—
	Alagoas	Porto Calvo	09°04'00" S	035°24'00" W	Kwon and Gardner 2008	222	—
	Amapá	Santa Luzia do Pacuí	00°30'00" N	051°40'00" W	Peracchi et al. 1984	97	ALP
	Amazonas	Biological Dynamics of Forest Fragments Project (BDFFP), 80 km N Manaus	02°24'26" S	059°43'40" W	Bernard 2001	119	INPA
	Amazonas	Manaus	03°06'00" S	060°01'00" W	Mok and Lacey 1980	339	—
	Amazonas	Parque Nacional do Jaú	01°50'00" S	062°50'00" W	Barnett et al. 2006	108	—
	Amazonas	Rio Aripuanã	06°08'13" S	060°11'37" W	Bobrowiec 2012	280	INPA
	Amazonas	Rio Madeira	05°27'58" S	060°45'07" W	Bobrowiec 2012	280	INPA
	Bahia	Baía do Rio São Francisco (Médio)	13°42'25" S	042°51'00" W	Sá-Neto and Marinho-Filho 2013	91	DCN/UESB
	Bahia	Mascote, Fazenda São José	15°34'05" S	039°17'07" W	Falcão 2007	330	DE 606
	Distrito Federal	Brazilândia, Gruta do Sal (DF-005), Fazenda Palestina	15°30'00" S	048°10'00" W	Aguiar et al. 2006	895	—
	Distrito Federal	Sobradinho, Área de Proteção Ambiental Cafuringa	15°35'00" S	048°01'00" W	Aguiar and Antonini 2016	3	—
	Goiás	Monte Alegre de Goiás	13°15'23" S	046°54'02" W	This Study	-	—
	Maranhão	Área de Proteção Ambiental Municipal do Inhamum	04°53'30" S	043°24'53" W	Olímpio et al. 2016	3	—
	Mato Grosso	Cláudia, Renato River	11°24'00" S	055°02'00" W	Pedroso et al. 2018	155	MZUSP 35713
	Mato Grosso	Fazenda Acurizal	17°45'00" S	057°37'00" W	Schaller 1983	11	—
	Mato Grosso do Sul	Aquidauana	19°33'58" S	055°30'43" W	Oliveira et al. 2012	36	UNIDERP
	Mato Grosso do Sul	Caimã Forest and Resort	19°18'13" S	056°01'25" W	Urbíeta et al. 2017	3	—
	Mato Grosso do Sul	Campo Grande, Lagoa da Cruz, Instituto São Vicente	20°23'08" S	054°36'27" W	Urbíeta et al. 2017	1	ZUFMS CHI02310
	Mato Grosso do Sul	Coxim, Serra Coxim	18°35'21" S	054°48'13" W	Urbíeta et al. 2017	3	—
	Mato Grosso do Sul	Miranda-Abobral	19°46'55" S	056°40'38" W	Oliveira et al. 2012	36	UNIDERP
	Mato Grosso do Sul	Nhecolândia	18°47'28" S	056°02'03" W	Oliveira et al. 2012	36	UNIDERP
	Mato Grosso do Sul	Nhecolândia, Fazenda Rio Negro	19°34'22" S	056°14'36" W	Silva and Graciolli 2013	177	—
	Mato Grosso do Sul	Nhecolândia, Fazenda Rio Negro	19°34'22" S	056°14'36" W	Herrera et al. 2011	383	—
	Mato Grosso do Sul	Paraguay river	19°13'00" S	057°29'00" W	Bordignon and Shapiro 2018	259	—
	Minas Gerais	Esmeraldas	19°45'57" S	044°17'09" W	Urbíeta et al. 2017	3	—
	Minas Gerais	Lagoa Santa	19°42'44" S	043°56'32" W	Torquetti et al. 2013	1148	MZ 270
	Minas Gerais	Uberaba	19°44'50" S	047°56'21" W	Stutz et al. 2004	190	—
	Minas Gerais	Uberlândia	18°55'08" S	048°16'39" W	Urbíeta et al. 2017	3	—
	Pará	Belém	01°27'21" S	048°29'15" W	Handley 1967	213	—
	Pará	Belém, Área de Pesquisas Ecológicas do Guamá, e áreas do Instituto de Pesquisa e Experimentação Agropecuárias do Norte	02°39'00" S	055°22'00" W	Kalko and Handley 2001	322	—
	Pará	Melgaço, Estação Científica Ferreira Penna	01°48'00" S	050°43'00" W	Marques-Aguiar et al. 2003	2	—
	Pará	Rio Xingu, Usina Hidrelétrica Belo Monte	03°20'00" S	052°00'00" W	Marques-Aguiar et al. 2009	2	—
	Pará	Santarém	02°24'52" S	054°42'36" W	Piccinini 1974	20	—
	Paraíba	Araruna, Parque Estadual Pedra da Boca, Mata Seca	06°27'43" S	035°41'21" W	Feijó et al. 2010	723	UFPB 5573
	Paraíba	Reserva Biológica Guaribas	06°48'18" S	035°04'60" W	Feijó et al. 2016	65	UFPB 7456
	Paraná	Bacia do Rio Tibagi	24°06'07" S	050°53'06" W	Reis et al. 2002	255	—

**Table A1. Continued.**

Country	State/province	Locality	Latitude	Longitude	Reference	Page	Coll. number
Brazil	Paraná	Cerro Azul	24°49'00" S	049°15'00" W	Graciolli and Carvalho 2001	935	—
	Paraná	Londrina, Parque Estadual Mata dos Godoy	23°27'00" S	051°15'00" W	Reis et al. 2003	228	—
	Paraná	Palmeira	25°25'00" S	050°00'00" W	Thomas 1899	547	—
	Paraná	Parque Nacional do Iguaçu	25°36'00" S	054°35'00" W	Sekiama et al. 2001	752	LZUEL
	Paraná	Ponta Grossa, Campos Gerais	25°50'58" S	050°09'30" W	Zanon and Reis 2007	329	—
	Paraná	Roça Nova	25°28'00" S	048°58'00" W	Miller 1906	84	USNM 140769
	Pernambuco	Ipojuca, Usina Salgado, Mata do Mingú	08°31'29" S	035°03'26" W	Sotero-Caio et al. 2011	158	—
	Pernambuco	Jaqueira, RPPN Frei Caneca	08°42'37" S	035°50'01" W	Silva et al. 2010	88	—
	Pernambuco	São Lourenço da Mata, Estação Ecológica do Tapacurá	08°02'00" S	035°13'00" W	Mares et al. 1981	111	—
	Piauí	Picos	07°04'39" S	041°28'02" W	Pinto and Bento 1986	32	—
	Piauí	São Miguel do Tapuio	05°43'13" S	041°26'28" W	Castilho et al. 2010	1335	—
	Rio de Janeiro	Angra dos Reis	23°00'00" S	044°18'00" W	Bolzan et al. 2010	589	—
	Rio de Janeiro	Angra dos Reis, Ilha da Gipóia	23°02'20" S	044°21'35" W	Costa and Esbérard 2011	741	—
	Rio de Janeiro	Baía de Sepetiba, Mangaratiba, Ilha de Marambaia, Praia Grande	22°04'26" S	043°57'56" W	Costa et al. 2008	218	LDM 4314
	Rio de Janeiro	Barra Mansa	22°32'27" S	044°10'38" W	Peracchi and Albuquerque 1971	410	—
	Rio de Janeiro	Carmo	21°55'00" S	042°36'00" W	Costa et al. 2008	218	—
	Rio de Janeiro	Casimiro de Abreu, Morro de São João	22°29'96" S	041°58'92" W	Costa et al. 2008	218	—
	Rio de Janeiro	Guapiaçú, Reserva Ecológica de Guapiaçú	22°25'53" S	042°45'20" W	Souza et al. 2015	14	MN 79877
	Rio de Janeiro	Guapimirim, Parada Modelo	22°33'24" S	042°55'71" W	Costa et al. 2008	218	—
	Rio de Janeiro	Mangaratiba	22°56'34" S	044°02'26" W	Bolzan et al. 2010	589	—
	Rio de Janeiro	Mangaratiba, Fazenda Terras do Sahy	22°56'00" S	044°00'00" W	Costa and Esbérard 2011	741	—
	Rio de Janeiro	Mangaratiba, Ilha de Marambaia	23°04'03" S	043°53'14" W	Costa and Esbérard 2011	741	—
	Rio de Janeiro	Miracema	21°24'55" S	042°11'39" W	Barros et al. 2008	684	—
	Rio de Janeiro	Quissamã, Parque Nacional Restinga de Jurubatiba	22°06'14" S	041°28'12" W	Costa et al. 2008	218	—
	Rio de Janeiro	Rio de Janeiro, Barra da Tijuca	23°00'22" S	043°17'49" W	Costa et al. 2008	218	—
	Rio de Janeiro	Rio de Janeiro, Barra de Guaratiba	22°59'45" S	043°32'21" W	Costa et al. 2008	218	—
	Rio de Janeiro	RPPN Fazenda Bom Retiro	22°27'13" S	042°18'29" W	Menezes Junior et al. 2015	272	—
	Rio de Janeiro	Seropédica, Campus da Universidade Federal Rural do Rio de Janeiro	22°45'54" S	043°41'12" W	Peracchi and Albuquerque 1986	67	—
	Rio de Janeiro	Três Rios, Bemposta	22°07'00" S	043°12'20" W	Costa et al. 2008	218	—
	Rio de Janeiro	Valença, Refúgio da Vida Silvestre da Serra da Concórdia	22°22'18" S	043°47'23" W	Costa et al. 2008	218	—
	Rio de Janeiro	Volta Redonda	22°30'27" S	044°05'40" W	Costa et al. 2008	218	—
	Rio de Janeiro	Volta Redonda, Parque Natural Municipal Fazenda Santa Cecília do Ingá	22°27'34" S	044°04'51" W	Pereira et al. 2013	1018	—
	Rondônia	Porto Velho	08°46'00" S	063°54'00" W	Tavares et al. 2017	96	—
	Rondônia	Porto Velho, Abunã	09°35'00" S	065°03'00" W	Pedroso et al. 2018	155	MZUSP 35712
	São Paulo	Bilac	21°24'16" S	050°28'30" W	Garbino 2016	82	DZSJP 10705
	São Paulo	Botucatu	22°59'20" S	048°26'37" W	Uieda and Chaves 2005	225	—
	São Paulo	Grota Mirassol	20°46'00" S	049°28'00" W	Garbino 2016	82	DZSJP 2556
	São Paulo	Guararema	23°25'00" S	046°01'00" W	Garbino 2016	82	DZSJP 15156
	São Paulo	Iporanga, Parque Estadual Turístico Alto do Ribeira, Gruta do Alambari de Baixo (SP-012)	24°33'15" S	048°39'55" W	Trajano 1987	538	—
	São Paulo	Itajobi	21°19'00" S	049°03'00" W	Garbino 2016	82	DZSJP 15025
	São Paulo	Santa Gertrudes, Fazenda Paraguassu	22°27'00" S	047°32'00" W	Sazima and Uieda 1980	102	ZUEC 1001
	São Paulo	São José do Rio Preto	20°49'11" S	049°22'45" W	Garbino 2016	82	DZSJP 16978
	São Paulo	São Paulo	23°32'52" S	046°38'10" W	Vieira 1942	380	MZUSP 4036
	São Paulo	São Sebastião, Barra do Una	23°46'00" S	045°45'00" W	Garbino 2016	82	MZUSP 9462
	São Paulo	Uchoa	20°57'00" S	049°10'00" W	Garbino 2016	82	DZSJP 16615
	Tocantins	Couto Magalhães, near electric power transmission line	08°21'00" S	049°10'00" W	Pedroso et al. 2018	156	MZUSP 35358
	Tocantins	Estação Ecológica Serra Geral do Tocantins, Jalapão	10°33'00" S	046°45'00" W	Gregorin et al. 2011	303	EG 323
Colombia	Putumayo	Río Mecaya	00°28'00" N	075°20'00" W	Wenzel et al. 1966	600	—
	Valle del Cauca	Río Raposo	03°38'00" N	077°05'00" W	Wenzel et al. 1966	600	—
Costa Rica	Guanacaste	Finca La Pacífica	10°27'16" N	085°07'41" W	Gardner et al. 1970	723	LSUMZ 22533
Ecuador	Esmeraldas	San Lorenzo	01°17'00" N	078°50'00" W	Pinto et al. 2007	244	TTU 85358
El Salvador	La Paz	1 mi N La Herradura	13°21'52" N	088°57'00" W	Owen et al. 1990	418	—
	La Paz	3 mi NW La Herradura	13°22'51" N	088°58'53" W	Greenbaum and Jones 1978	5	TTU 27591
French Guiana	Cayenne	Paracou	05°16'00" N	052°55'00" W	Bernard and Fenton 2002	1137	—
Guyana	East Berbice-Corentyne	Upper Canje Creek	05°07'00" N	057°37'00" W	Jentink 1893	282	RNH 12088
	Potaro-Siparuni	Iwokrama Forest	04°40'00" N	058°41'00" W	Bernard and Fenton 2002	1137	—
	Rupunini	Kanunu Mountains	03°22'00" N	059°30'00" W	Barnett et al. 2006	125	—

**Table A1. Continued.**

Country	State/province	Locality	Latitude	Longitude	Reference	Page	Coll. number
Mexico	Chiapas	Ejido Benemérito de Las Américas	16°31'02" N	090°39'11" W	Urbano-Vidales et al. 1987	135	—
	Mazu	Montes Azules	16°50'00" N	091°30'00" W	Bernard and Fenton 2002	1137	—
Nicaragua	Managua	0.75 mi N Masachapa	11°47'24" N	086°31'00" W	Greenbaum and Jones 1978	5	TTU 30667
	South Caribbean Coast Autonomous Region	3 km NW Rama	12°10'43" N	084°13'12" W	Greenbaum and Jones 1978	5	TTU 30668
Panama	Bocas del Toro	Isla Bastimentos	09°21'00" N	082°12'00" W	Wenzel et al. 1966	600	—
	Guna Yala	Río Armilla	09°02'40" N	078°01'14" W	Wenzel et al. 1966	496	—
	Alto Paraguay	Estancia General Díaz, 100 km W Fuerte Olimpo	21°08'00" S	058°30'00" W	López-González et al. 1998	42	FMNH 145266
	Alto Paraguay	Estancia Parra Cue	02°05'54" S	047°53'31" W	López-González et al. 1998	42	TTU 75276
	Boquerón	Parque Nacional Defensores del Chaco, Cruce Cuatro de Mayo, destacamento Patricio Colmán	20°13'00" S	060°12'00" W	López-González et al. 1998	42	MNHNP 823
	Presidente Hayes	Estancia La Victoria	23°29'02" S	058°34'47" W	López-González et al. 1998	42	TTU 75273
	Presidente Hayes	Estancia Loma Pora	23°29'56" S	057°32'53" W	López-González et al. 1998	42	TTU 75278
Peru	Huánuco	Cueva de Castillo	09°07'00" S	075°58'00" W	Bowles et al. 1979	7	—
	Huánuco	Cueva de Lechuzas	09°20'00" S	076°01'00" W	Bowles et al. 1979	7	—
	Huánuco	Panguana Biological Station	09°37'00" S	074°56'00" W	Hutterer et al. 1995	5	—
	Loreto	Colonia Calleria, 20 km from Río Ucayali	08°06'00" S	074°36'00" W	Wenzel et al. 1966	600	—
	Loreto	Pebas	03°20'00" S	071°49'00" W	Thomas 1928	288	NHM 1928.7.21.64
	Tumbes	Distrito Pampas de Hospital, Angostura	03°45'23" S	080°23'15" W	Pacheco et al. 2007	412	MUSM 22132
	Ucayali	Yarinacocha	08°15'00" S	074°43'00" W	Sanborn 1949	282	—
Trinidad & Tobago	Trinidad	Barataria	10°39'00" N	061°28'00" W	Kwon and Gardner 2008	222	USNM 536938
	Trinidad	La Brea	10°15'00" N	061°37'00" W	McBee et al. 1985	404	TTU 26888
	Trinidad	Las Cuevas	10°46'00" N	061°23'00" W	Greenhall 1963	397	—
	Trinidad	Majuba Road, Petit Valley	10°42'00" N	061°32'00" W	Brennan 1967	154	—
	Trinidad	Maracas Valley	10°41'00" N	061°24'00" W	McBee et al. 1985	404	TTU 5232
Venezuela	Amazonas	San Juan de Manapiare	05°15'00" N	066°05'00" W	Bernard & Fenton 2002	1137	—
	Bolívar	Canaima National Park	06°10'00" N	062°30'00" W	Barnett et al. 2006	125	—
	Delta Amacuro	Araguaimujo	08°54'00" N	061°32'00" W	Kwon and Gardner 2008	222	—
	Falcón	6 km SE Capatárida	11°07'00" N	070°35'00" W	Kwon and Gardner 2008	222	—
	Nueva Esparta	El Valle	10°59'00" N	063°52'00" W	Kwon and Gardner 2008	222	—
	Zulia	El Panorama, Río Aurare	10°37'00" N	071°25'00" W	Osgood 1912	63	—